

**PHYS 400-01**

**Photovoltaic Stove Research**

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**Introduction:**

Physics 400 consisted of research for the design and implementation of a photovoltaic stove for third world countries. Through this class I was also able to gain a partnership with Aid Africa who provides aid to a village in Gulu, Africa. For the Summer 2016 we have partnered to build photovoltaic stoves in Gulu, Africa.

**Photovoltaic stove research**

**Thermostat Switches**

Once the first prototype of the photovoltaic stove was built, we needed to implement a way to switch the stove on and off. In the first prototype we used an Arduino microcontroller to shut on and off the heating element through a relay. This was not the best solution due to the complexity of setting up the electronics in Gulu, Africa. Professor Schwartz guided me to use a much simpler device such as a thermal activated switch. I conducted research on the different technical characteristics of all the different temperature controlled switches. Professor Schwartz agreed that the temperature controlled switch thermostat shown in figure 1 would be the best choice due to the low cost and functionality. The switch from figure 1 is a normally closed switch and as soon as the temperature reaches 150 degrees Celsius the switch opens to stop the current from flowing. The 24V solar panel we are using is well under the characteristics of the switches limit. In table 1 you are able to see all the specifications for the KSD301 temperature switch.



Figure 1: KSD301 Temperature controlled switch.

Table 1: KSD301 Specifications

|  |  |
| --- | --- |
| Model | KSD301 |
| Action Type | Normally closed |
| Max Voltage | 125V |
| Max Current | 16A |
| Max temperature | 220C |
| Reset temperature | 150C |
| Circuit Resistance | 50m Ohm |
| Dimensions | 1.3" x 0.47" (L\*H) |
| Mounting hole spacing | 0.94" |
| Material | Bakelite/Aluminum |
| Connection | No polarity, reversible |

The second type of switch is similar to a barbeque grill switch. The stove user would be able to adjust how much current is being provided to the heating element and thus varying the temperature. The capillary thermostat is shown in figure 2. As shown in table 2, this thermostat would fit our specifications for the solar stove. The maximum current that our 100W solar panel could provide is 5A.



Figure 2: Capillary thermostat.

Table 2: Uxcell Temperature Capillary thermostat specifications

|  |  |
| --- | --- |
| Model | Uxcell Temperature Capillary thermostat |
| Action Type | Normally Closed |
| Max Voltage | 250V |
| Max Current | 16 A |
| Max temperature | 300C |
| Reset temperature | Adjustable through knob |
| Dimensions | 2.7 x 2.2" |
| Material | Plastic, Resin, Stainless steel probe |
| Connection | Two pins, no polarity |

**Charging Circuit**

If our system is insulated well enough, we will have excess energy generated from the PV panel. We considered adding an electrical storage system to our solar cooker, but found that the additional cost of such system would put us over budget. After the first prototype is built, we will reanalyze the cost of the system. If there is additional funding in our budget we shall implement the energy storage system.

The electrical storage system should be very easy to implement once we get the prototype to boil water in adequate time. We would simply divert the energy to a charging circuit similar to the one shown below in Figure 3, which is a charging circuit for lead-acid batteries. The most common batteries for energy storage are lead-acid batteries. We will test different batteries to see which is the most efficient.

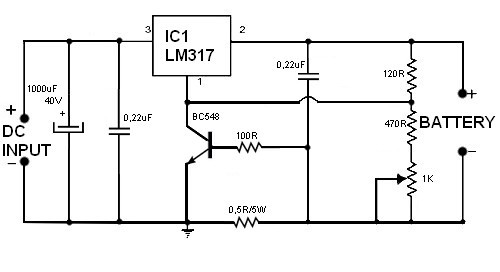


Figure 3: Charging Circuit for Lead-Acid Batteries

The charging circuit will be capable of charging two 12V 7Ah lead-acid batteries. A lead acid battery should be charged at 1/10 its Ah value. The 1k potentiometer can be adjusted to set the desired current. In this case we connect the batteries in parallel to maintain the 12V and increase the capacity. We are able to calculate the charging current by performing the following calculation: Charging current = (1/10h)\*14Ah= 1.4Amperes. The total charging time for these batteries can be calculated as: 14Ah/1.4A = 10 hours to fully charge the batteries. The input of pin three of the LM317 should be at least 15V to ensure the proper voltage is provided to the charging circuit. A heat sink will be beneficial for the LM317 since it will get hot.

Once the first prototype was built, I served as a “go to” person to help other students that were looking to implement a similar design for their own use. Research that was conducted on the first prototype was passed down to them and also helped answer any additional questions on the electrical circuit that is involved.

**Uganda trip**

Through the partnership that Professor Schwartz started with Aid Africa this year, I will be traveling to Gulu Africa to install photovoltaic stoves. As part of Physics 400 I met with Professor Schwartz each Friday to plan out the trip and logistics. With the help of professor Schwartz we were able to come up with an initial prototype that could be implemented in Gulu. The second prototype will be built this summer 2016 before taking the trip to Africa. I will help with the implementation and design process. Before our trip we plan on being in contact with personnel that is already in Gulu to ensure that the materials we use in our prototype are readily available. The logistics of the trip consisted of multiple interactions with Aid Africa personnel. I served as a backup leader to attend meetings when there was time conflict and our trip leader was unable to attend. I would then take notes or audio recording and passed the information to the trip leader.